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Indian Standard

IS 10594 : 2021

ताप स्थैतिक विस्तारक वाल्व के लिए विशिष्टि

(पहला पुनरीक्षण)

Specification for Thermostatic Expansion Valves

(First Revision)

ICS 23.060; 27.200

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Refrigeration and Air Conditioning Sectional Committee, MED 03

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air Conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This Indian Standard was first published in 1983. The committee responsible to formulate this Standard decided to revise the existing Standard in view of the change in the technology available at present. The following are the major changes in this revision:

a) New definitions have been added;
b) Scope has been modified;
c) Type, model and basic differentiating parameters are added;
d) Classification method is added;
e) Marking and color code has been replaced with marking, packaging, transportation and storage;
f) Test procedures as given in Annex A is updated and new procedures are added;
g) The parameters 'evaporation temperature range (high temperature, medium temperature, middle-low temperature and low temperature)' is added;
h) The nominal working condition is modified;
i) The requirements for 'hydraulic strength test', 'air tightness test', 'nominal cooling capacity' and 'working life' are modified; the requirements for 'hysteresis' are added; and
j) Leak test method modified and elaborated; and
k) Terminology related to capacity calculation modified and calculation method of nominal cooling capacity explained in detail.

The composition of the Committee, responsible for the formulation of this standard is given at Annex B.

For the purpose of deciding whether a specific requirement of this code is complied with the final value, observed or calculated, expressing the results of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SPECIFICATION FOR THERMOSTATIC EXPANSION VALVES

(First Revision)

1 SCOPE

1.1 This standard specifies the terms, definitions, types, basic parameters, requirements, testing, marking, packing, transportation and storage of thermostatic refrigerant expansion valve (hereinafter referred to as 'expansion valve') of various types as listed in **4.1**.

1.2 This standard is applicable to the thermostatic expansion valves for refrigeration with R22, R134a, R404A, R407C, R410A, R507, R290, R32 and R23 evaporating at the temperature of –60 °C to 15 °C.

NOTE — This standard may be used as a reference for other thermostatic expansion valves with other refrigerants.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in Annex A.

3 TERMINOLOGY

For the purpose of this standard the following definitions shall apply:

3.1 Thermostatic Refrigerant Expansion Valve — Thermostatic refrigeration expansion valve (often abbreviated as TEV, TXV, or TX valve) is a control element which automatically adjusts the flow of liquid refrigerant entering the evaporator of refrigeration equipment according to the pressure change of the evaporator and gas superheat degree of refrigerant at the outlet of evaporator.

3.2 Internal Equalization — An equalization method to transmit the outlet pressure of expansion valve (inlet pressure of evaporator) to the executing element of the valve (diaphragm or corrugated pipe) through the internal channel of the valve.

3.3 External Equalization — An equalization method to transmit the outlet pressure of the evaporator to the executing element of the valve through the external equalization pipe, which is used to compensate for the pressure reduction when the refrigerant flows through the distributor and evaporator.

3.4 Superheat — The superheat of internal equalization expansion valve is the difference between the temperature of sensing bulb and the refrigerant saturated temperature corresponding to the pressure at the outlet of the expansion valve.

The superheat of external equalization expansion valve means the difference between the temperature of sensing bulb and the saturated temperature corresponding to the connection of external equalizer (outlet pressure of evaporator).

3.5 Static Superheat — A superheat value set to control the heat generated in the process from closing to opening of the expansion valve or from opening to closing the expansion valve.

3.6 Opening Superheat — The superheat required for opening the expansion valve to the degree corresponding to the nominal cooling capacity.

3.7 Working Superheat — The sum of static superheat and opening superheat of the expansion valve.

3.8 Sub Cooled (Flash Gas Free) Liquid — The liquid refrigerant cooled to below the saturated temperature under a certain pressure.

3.9 Pressure Drop — The difference between the inlet pressure and outlet pressure of the expansion valve.

3.10 Hysteresis — The difference between the opening superheat and closing superheat of the expansion valve at the same refrigerant flow.

3.11 Nominal Cooling Capacity — The refrigerant flow through the expansion valve multiplied by the difference between the enthalpy value at the inlet of the expansion valve and the saturated steam enthalpy value at the evaporation temperature under the specified test condition of cooling capacity.

3.12 Max working pressure (MWP) — Maximum pressure for which system or component is designed for, as specified by the manufacturer. Alternatively, it is known as maximum allowable pressure or PS. It is the limit which should not be exceeded whether the system is working or not.

4 TYPE, MODEL, AND OPERATING PARAMETERS

4.1 Type

Thermostatic expansion valves are classified based on following criteria:

4.1.1 *Equalization Method*

Internal equalization and external equalization.

4.1.2 *Flow Direction*

Unidirectional flow and bidirectional flow.

4.1.3 *Refrigerant*

R22, R134a, R404A, R407C, R410A, R507, R507A, R290, R23 and R32.

4.1.4 *Flow Opening Type*

Single flow opening and equalized flow opening.

4.1.5 *Connection Method*

Welding, thread, and flange.

4.1.6 *Flow-through Method*

Straight-through flow and angle type.

4.1.7 *Pressure-limiting Method*

General and pressure limiting.

4.1.8 *Installation Method of Temperature-sensing Element*

Remote temperature-sensing element and internal temperature-sensing element.

4.1.9 *Orifice Type*

Exchangeable orifice and unexchangeable orifice.

4.1.10 *Super Heat Setting Adjustment Type*

Adjustable and non-adjustable.

4.1.11 *Balance Port*

With balance port and non-balance port.

4.1.12 *Check Valve*

With check valve and without check valve.

4.1.13 *Bleed Hole*

With internal bleed hole and without internal bleed hole.

4.2 Model

The model of expansion valve can be determined by the manufacturer at its own discretion, but the nominal cooling capacity and refrigerant applicable to the expansion valve shall be reflected as a specification in the marking.

4.3 Operating Parameters

4.3.1 *Range of Evaporation Temperature of the Expansion Valve*

The expansion valve shall work normally under the following conditions:

a) Range of evaporation temperature (high temperature): – 10 °C to 15 °C;
b) Range of evaporation temperature (medium temperature): – 25 °C to 10 °C;
c) Range of evaporation temperature (medium-low temperature): 40 °C to 10 °C; and
d) Range of evaporation temperature (low temperature): – 60 °C to – 25 °C.

4.3.2 The nominal cooling capacity of the expansion valve shall be determined according to the nominal working conditions in Table 1.

Table 1 Nominal Working Conditions

(*Clauses* 4.3.2, 5.7, 6.1.2, 6.3, 6.8 *and* 6.10.1)

Sl No.	Nominal Working Condition	Temperature of Liquid Refrigerant Entering the Expansion Valve in ºC	Condensing Temperature * in ºC	Evaporation Temperature # in ºC	Static Superheat of Expansion Valve in ºC	Opening Superheat of Expansion Valve in ºC
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	a			5		
ii)	b	34	38	– 7	4	4
iii)	c			– 23		
iv)	d			– 40		

* Measured at the inlet of expansion valve, the condensing temperature of the mixed refrigerants is the condensing bubble point temperature.

Measured at the outlet of expansion valve (internal equalization type) or at the external equalization pipe of expansion valve (external equalization type), the evaporation temperature of mixed refrigerants is the evaporation dew point temperature.

5 GENERAL REQUIREMENTS AND MATERIAL OF CONSTRUCTION

5.1 Material

All working parts of expansion valve shall be compatible to meet with the product functional requirements and all test requirements and typically be constructed using brass, bronze, copper, carbon steel, stainless steel etc (*see* IS 292, IS 410, IS 6911 etc.).

5.2 Hydraulic Strength Test

5.2.1 *Pressure Test*

Expansion valve shall be pressure tested without leakage. There shall be no visual deformation and cracks (for test method *see* **6.4.1**).

5.2.2 *Burst Test*

Expansion valve shall be pressure tested and free of leakage or cracking (for test method *see* **6.4.2**).

5.3 Tightness Test

The tightness can be tested by helium. The leakage rate of expansion valves shall be less than 6.4×10^{-6} mbar·L/s, and the leakage rate of the power head shall be less than 1×10^{-6} mbar·L/s (for test method *see* **6.5**).

5.4 Corrosion Test

Thermostatic expansion valve shall be constructed of any corrosion-resistant materials and shall conform to the Salt Spray test specified in IS 9844 for duration not less than 72 h.

5.5 Environmental Heat Resistance

During the test of environmental heat resistance, the temperature-sensing element of expansion valves shall be free from leakage (for test method *see* **6.6**).

5.6 Leakage Rate of External Equalizer

The leakage rate of external equalization pipe for expansion valves shall comply with the specifications in Table 2 or the contractual specifications (for test method *see* **6.7**).

Table 2 Leakage Rate of External Equalizer of Expansion Valves

(*Clause* 5.6)

Sl No.	Nominal Cooling Capacity (Q) kW	Internal Leakage Rate mL/min of Air at 0.15 MPa.
(1)	(2)	(3)
i)	$Q \le 7$	≤ 100
ii)	$7 < Q \le 70$	≤ 150
iii)	$Q > 70$	≤ 200

5.7 Ex-factory Static Superheat

The static superheat of expansion valves shall conform to the requirements of static superheat in Table 1 or the contractual specifications (*see* **6.8**).

5.8 Internal Leakage of Throttle Opening

The actual leakage rate of the throttle opening of expansion valves shall be not more than 1 percent of the nominal flow rate or the contractual specifications (for test method *see* **6.9**).

5.9 Nominal Cooling Capacity

The measured cooling capacity of expansion valves shall not be less than 95 percent of the nominal cooling capacity. The forward and reverse cooling capacity of bidirectional expansion valves shall not be less than 95 percent of the nominal cooling capacity. The maximum measured cooling capacity shall not be less than 120 percent of the nominal cooling capacity (for test method *see* **6.10**).

5.10 Extended Cooling Capacity

For expansion valve of each model, it is required to provide the extended cooling capacity data, namely, the cooling capacity at different evaporating temperatures and pressure drops (or different condensing temperatures).

5.11 Hysteresis

The measured hysteresis of the expansion valves shall not be more than 2K or shall comply with the contractual specification (for test method *see* **6.11**).

5.12 Vibration Resistance

After vibration resistance test, the expansion valves shall function properly and the retested static superheat shall reach the original default value with in the specified tolerance (for test method *see* **6.12**).

5.13 Working Life

After the working life test, the expansion valves shall function properly and the retested static superheat shall reach the original default value with in the specified tolerance (for test method *see* **6.13**).

5.14 Lifetime of Capillary

The capillary should withstand minimum seven bending cycles without any rupture or crack (for test method *see* **6.14**).

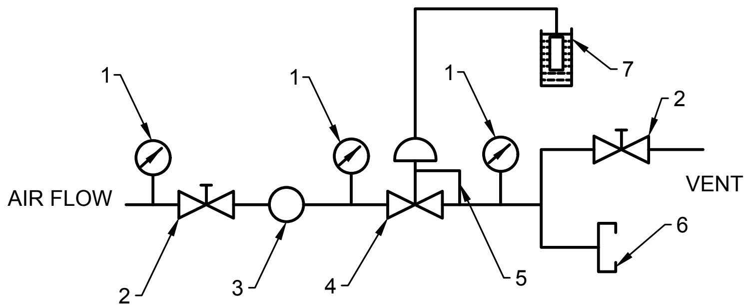
6 TEST METHODS

6.1 Test Conditions

6.1.1 *Test Apparatus*

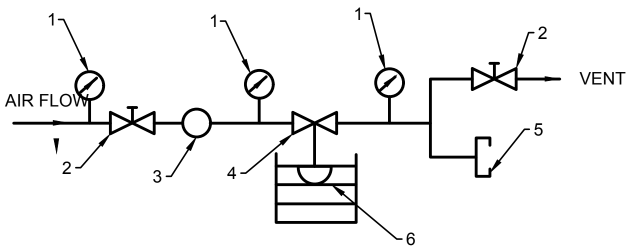
6.1.1.1 The air flow test principle for expansion valves with a remote temperature-sensing element is as shown in Fig. 1.

6.1.1.2 Air flow test principle for expansion valves with an internal temperature-sensing element is as shown in Fig. 2.



1. PRESSURE GAUGE; 2. MANUAL VALVE; 3. PRESSURE REGULATOR; 4. TESTED EXPANSION VALVE; 5. EXTERNAL EQUALIZATION PIPE; 6. FLOWMETER; 7. THERMOSTATIC BATH

FIG. 1 SCHEMATIC DIAGRAM OF AIR FLOW TEST FOR EXPANSION VALVES WITH A REMOTE TEMPERATURE-SENSING ELEMENT



1. PRESSURE GAUGE; 2. MANUAL VALVE; 3. PRESSURE REGULATOR; 4. TESTED EXPANSION VALVE; 5. FLOW MEASURING INSTRUMENT; 6. THERMOSTATIC BATH.

FIG. 2 AIR FLOW TEST PRINCIPLE DIAGRAM FOR EXPANSION VALVES WITH AN INTERNAL TEMPERATURE-SENSING ELEMENT

6.1.1.3 Refrigerant flow test principle for expansion valves with a remote temperature-sensing element is as shown in Fig. 3.

6.1.1.4 Refrigerant flow test principle for expansion valves with an internal temperature-sensing element is as shown in Fig. 4.

6.1.1.5 The leakage test principle of the external equalization pipe is as shown in Fig. 5.

6.1.1.6 The working life test principle for expansion valves is as shown in Fig. 6.

6.1.2 *Test Working Conditions*

According to the types of expansion valves, it is required to choose test working conditions according to Table 1.

6.1.3 *Type and Accuracy of Apparatus and Instruments*

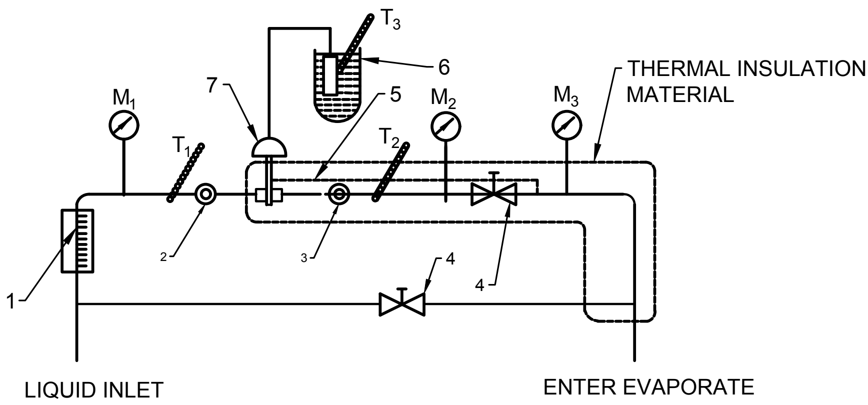
The type and accuracy of apparatus and instruments for tests shall abide by the stipulation in Table 3.

6.1.4 *Permissible Deviation for the Measured Value of Test Working Condition*

When the expansion valve is subject to the working conditions test, the permissible deviation for the reading value of test condition parameters shall comply with the stipulation in Table 4.

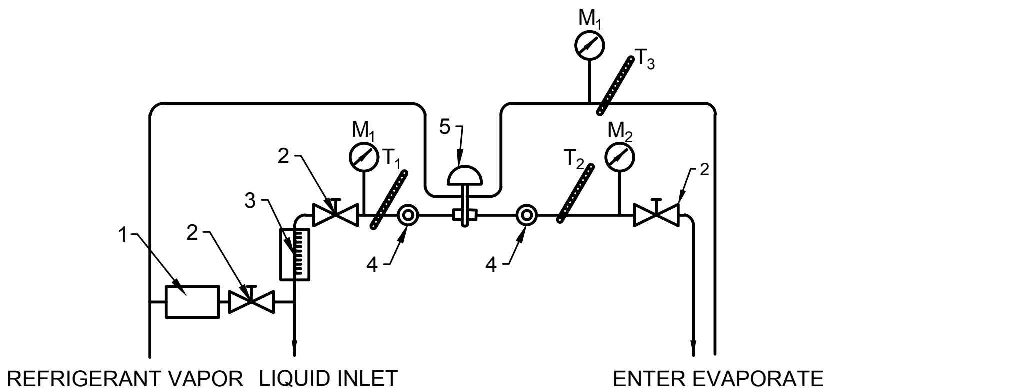
6.2 Test Procedures

6.2.1 In the flow test apparatus for the expansion valve, if the oil content of its liquid refrigerant-oil mixture is no more than 2 percent there is no need to correct the cooling capacity according to the oil content.



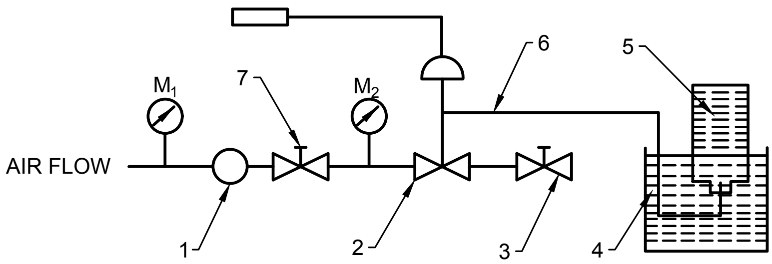
1. FLOW MEASURING INSTRUMENT; 2,3. LIQUID LEVEL INDICATOR; 4. MANUAL THROTTLE VALVE;
5. EXTERNAL EQUALIZATION PIPE'; 6. THERMOSTATIC BATH; 7. TESTED EXPANSION VALVE;
T1,T2,T3 - THERMOMETER; M1, M2, M3 - PRESSURE GAUGE.

FIG. 3 SCHEMATIC DIAGRAM OF REFRIGERANT FLOW TEST FOR EXPANSION VALVES WITH A REMOTE TEMPERATURE-SENSING ELEMENT



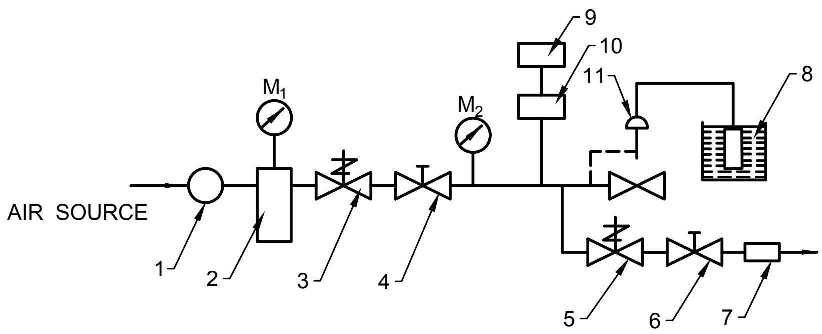
1. AUXILIARY EVAPORATOR 2. MANUAL THROTTLE VALVE 3. FLOW MEASURING INSTRUMENT
4. LIQUID LEVEL MIRROR 5. TESTED EXPANSION VALVE
T1,T2,T3. - THERMOMETER; M1, M2, M3. - PRESSURE GAUGE.

FIG. 4 SCHEMATIC DIAGRAM OF REFRIGERANT FLOW TEST FOR EXPANSION VALVES WITH AN INTERNAL TEMPERATURE-SENSING ELEMENT



1. PRESSURE REGULATOR; 2. TESTED EXPANSION VALVE; 3. MANUAL VALVE; 4. SINK;
5. FLOW MEASURING INSTRUMENT; 6. EXTERNAL EQUALIZATION PIPE; 7. MANUAL VALVE
M1, M2, - PRESSURE GAUGE.

FIG. 5 LEAKAGE TEST PRINCIPLE FOR EXTERNAL EQUALIZATION PIPE



1. REGULATOR; 2. CONTAINER; 3. MAGNETIC VALVE; 4. MANUAL VALVE;
5. MAGNETIC VALVE; 6. MANUAL VALVE; 7. SILENCER; 8. THERMOSTATIC BATH;
9. COUNTER; 10. PRESSURE CONTROLLER; 11. TESTED EXPANSION VALVE.

FIG. 6 SCHEMATIC DIAGRAM OF WORKING LIFE TEST FOR EXPANSION VALVES

Table 3 Type and Accuracy of Apparatus and Instruments

(*Clause* 6.1.3)

Sl No.	Category	Type	Accuracy
(1)	(2)	(3)	(4)
i)	Temperature measurement instrument	Mercury-in-glass thermometer, electric resistance thermometer, thermocouple	Air temperature: ±0.3 °C Refrigerating system temperature: ±0.1 ºC
ii)	Flow control measuring instrument	Record, indication, accumulation, etc.	Measuring flow ±1.0 percent
iii)	Refrigerant pressure measuring instrument	Pressure gauge, transmitter	Measuring pressure ±2.0 percent
iv)	Time measuring instrument	Chronograph	Measuring time ±0.2 percent

Table 4 Permissible Deviation for the Reading Value of Test Condition Parameters

(*Clause* 6.1.4)

Sl No.	Test parameters	Maximum Deviation between Measured Value and Specified Value	Maximum Deviation between the Measured Values and the Average Value
(1)	(2)	(3)	(4)
i)	The temperature of liquid refrigerant entering the expansion valve	±3 °C	±2 °C
ii)	The pressure of refrigerant entering the expansion valve	±2 percent	±1 percent
iii)	Refrigerant evaporating temperature	±3 °C	±1 °C
iv)	Refrigerant back pressure *	±2 percent	±1 percent
v)	Flow of refrigerant and secondary refrigerant	±5 percent	±2 percent

* When measuring the refrigerant pressure corresponding to the evaporating temperature, the permissible deviation of the former shall correspond to that of the latter, namely, ensure that the maximum deviation between the evaporating temperature corresponding to the refrigerant pressure and the specified value shall be ±3 ºC and the maximum deviation of the measured values to the average value shall be ±1 ºC.

6.2.2 *Adjusting Range of Static Superheat*

After the test, the adjusting range of static superheat for expansion valves shall be 0K ~ 8K.

6.2.3 In the test apparatus, a certain straight-line distance shall be kept between the inlet and outlet pipes for expansion valves horizontally. The length of the straight section of the inlet pipe shall be more than six times of the inner diameter of the pipe and that of the straight section of the outlet pipe shall be more than six times of the inner diameter of the pipe. The test point of temperature and pressure shall be set at a distance within six times of the inner diameter of inlet and outlet pipes from the inlet and outlet of the expansion valve under the test of maximum capacity by the equipment.

6.3 Test for Adjusting Range of Static Superheat

Install the expansion valves on the apparatus shown in Fig. 1 or Fig. 2 and place the temperature-sensing bulb in the thermostatic bath (the temperature of the thermostatic bath is the evaporating temperature under the nominal cooling working condition + 4 °C or complies with the contractual specification); adjust the inlet pressure of the expansion valve to the refrigerant saturation pressure corresponding to the condensing temperature in Table 1 or the refrigerant saturation pressure corresponding to the temperature specified by the user. During the test, always make the air flow flowing through the flow measuring instrument correspond to the minimum opening flow of the tested expansion valve and then rotate the adjusting bolt to the loosest position and the difference value between the saturation temperature corresponding to the outlet pressure is the minimum superheat; and rotate the adjusting bolt to the tightest position and the difference between the saturation temperature corresponding to the outlet pressure and the temperature of the thermostatic bath is the maximum superheat; the difference between the maximum superheat and minimum superheat is the adjusting range of static superheat.

6.4 Hydraulic Strength Test

6.4.1 *Pressure Test*

Connect the valve to air or liquid source and increase the pressure gradually up to at least 1.1 times of maximum working pressure and maintain for one minute. Tested valve shall fulfill the requirement of **5.2.1**.

6.4.2 *Burst Test*

Under the safety protections connect the valve to liquid source and increase the pressure gradually to 5 times of maximum working pressure and maintain for 1 min. Alternatively, test shall be conducted at 3 times maximum working pressure for 1 min followed by cyclic test for 200 000 cycles. Minimum value be less than 0.2 × MWP and maximum value must be above 0.8 × MWP. Number of cycles to be 20 to 60 per minute followed by applying 3 times maximum working pressure for 1 min. Deformation and leakage must not be observed.

6.5 Test for Air Tightness

Connect the valve to helium source with pressure not lower than 1.0 MPa and make sure to test the leakage rate of the valve and the power head. The leakage rate shall fulfill the requirement of **5.3**.

6.6 Test for Environmental Heat Resistance

Place the expansion valve in the water of 80 ± 2 °C (temperature-sensing bulb of the expansion valve is aerated) or 55 ± 2 ºC (temperature-sensing bulb of the expansion valve is filled with fluid), for 1 h.

6.7 Leakage Test of External Equalization Pipe

Install the expansion valve in the apparatus shown in Fig. 5, switch off the manually operated valve 3 and adjust the pressure regulator until the indicated value on pressure gauge M_2 is 0.15 or 0.2 MPa. Measure the leakage passing through the external equalization pipe.

6.8 Adjustment of Ex-factory Static Superheat

Install the expansion valve on the apparatus shown in Fig. 1 or Fig. 2 and place the temperature-sensing bulb in the thermostatic bath (the temperature of the thermostatic bath is the evaporating temperature under the nominal cooling working condition +4 °C or complies with the contractual specification). First adjust the inlet pressure to the refrigerant saturation pressure corresponding to the condensing temperature in Table 1 or the refrigerant saturation pressure corresponding to the temperature specified by the user and then adjust the adjusting bolt of the expansion valve to make the outlet pressure be the saturation pressure corresponding to the evaporating temperature in Table 1.

6.9 Internal Leakage Test of Throttle Opening

After adjusting the static superheat, switch off the manual throttle valve 3 in Fig. 5 in the outlet of the expansion valve and test the leakage in the throttle opening.

6.10 Test for Nominal Cooling Capacity

6.10.1 *Test for Refrigerant Flow*

After adjusting the static superheat, install the expansion valve on the apparatus for the test of the refrigerant flow shown in Fig. 3 or Fig. 4.

a) Adjust the test working conditions to make the outlet pressure of the expansion valve be the refrigerant saturation pressure corresponding to the evaporating temperature in Table 1;
b) The temperature of the thermostatic bath gradually increases from the evaporating temperature in

Table 1 and with the temperature increment of 1 °C and it should be continued until it reaches 10 °C;

c) Continue to increase the temperature of the thermostatic bath until the superheat reaches 10 ºC;

d) Then gradually reduce the temperature of the thermostatic bath until the mass flow rate of the refrigerant reaches 'zero'; and

e) Record the temperature values of the temperature-sensing bulb and the mass flow rate values of the refrigerant in the entire process.

Draw a superheat-mass flow characteristic curve of the expansion valve; take the average value of opening flow and closing flow under the same superheat as the refrigerant mass flow value under the superheat and the difference value of the mass flow at G_2 and G_1 is the nominal flow value of the expansion valve, as shown in Fig. 7.

6.10.2 *Calculation Method of Nominal Cooling Capacity*

According to the superheat-flow characteristic curve of the expansion valve as shown in Fig. 7, the calculation formula of the nominal cooling capacity for the expansion valve can be obtained as:

$Q = (G_2 - G_1) \times (h_2 - h_1)$ ....(1)

$G_2 = (q_2 + q_2')/2$..(2)

$G_1 = (q_1 + q_1')/2$..(3)

where

Q = Nominal cooling capacity of the expansion valve, kW;

G_1 = Average mass flow at the initial point (superheat is the static superheat) of the expansion valve, kg/s;

G_2 = Average mass flow at the nominal point (superheat of this point is the sum of the static superheat and the opening superheat) of the expansion valve, kg/s;

q_1 = Opening mass flow at the initial point of the expansion valve, kg/s;

q_1' = Closing mass flow at the initial point of the expansion valve, kg/s;

q_2 = Opening mass flow at the nominal point of the expansion valve, kg/s;

q_2' = Closing mass flow at the nominal point of the expansion valve, kg/s;

h_1 = Specific enthalpy of the liquid refrigerant entering the expansion valve, kJ/kg; and

h_2 = Specific enthalpy of the saturated gas refrigerant vented from the evaporator, kJ/kg.

6.10.3 *Examples for Computing Cooling capacity*

Test conditions and the normal working conditions for an expansion valve for R22 refrigerant are given in Table 5.

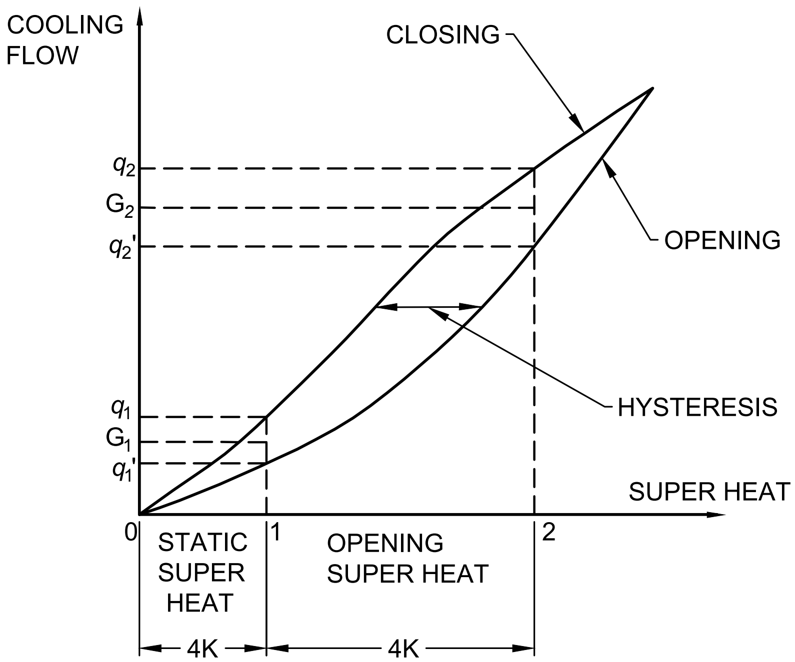


FIG. 7 SUPERHEAT-COOLING FLOW CURVE OF EXPANSION VALVE

Table 5 Examples of Test and Calculating Parameters

(*Clause* 6.10.3)

Sl No.	Used refrigerant	R22
	Test conditions	Nominal working conditions
(1)	(2)	(3)
i)	Opening mass flow at the initial point of the expansion valve kg/s	0.006 9
ii)	Closing mass flow at the initial point of the expansion valve kg/s	0.008 9
iii)	Opening mass flow at the nominal point of the expansion valve kg/s	0.144
iv)	Closing mass flow at the nominal point of the expansion valve kg/s	0.172
v)	Measured temperature of the liquid refrigerant entering the expansion valve ºC	34.5
vi)	Measured upstream pressure of the expansion valve kpa/condensing temperature ºC	1 461/38
vii)	Specific enthalpy of the liquid refrigerant entering the expansion valve kJ/kg	242.45
viii)	Measured outlet pressure of the expansion valve kpa/evaporating temperature ºC	587/5.2
ix)	Specific enthalpy of the saturated gas refrigerant vented from the evaporator kJ/kg	407.22

Then, according to the equation (1), (2) and (3), calculate the nominal cooling capacity of the expansion valve:

$Q = [(0.172 + 0.144)/2 - (0.0069 + 0.0089)/2] \times (407.22 - 242.45)$ kW = 24.73 kW

6.11 Hysteresis

According to the test in **6.10**, get the change of superheat when the expansion valve is open and closed under the same cooling capacity, as shown in Fig. 7.

6.12 Test for Vibration Resistance

Fix the expansion valve on the vibration test bed; conduct the vibration test in X, Y and Z Axis each for 2 h under 25 Hz and 1.5 mm amplitude. Conduct test for static superheat. The change in super heat before and after vibration test should be less than ± 1K.

6.13 Test for Working Life

Install the expansion valve on the apparatus shown in Fig. 6 and then close the inlet of the valve. Place the temperature-sensing bulb in the 30 ºC ± 1 ºC thermostatic bath. The test medium is clean and dry compressed air. Switch on the magnetic valve 3 and make the air pass through the diaphragm or the downside of the corrugated pipe, and then close the valve. Close the magnetic valve 3 and switch on the magnetic valve 5 and make the diaphragm move up and down with full valve stroke. Through adjusting the opening and closing time of the needle valve and magnetic valve, control the gas pressure and make it change under a certain frequency (for the fluctuation range of the gas pressure, the low pressure is the refrigerant pressure corresponding to the minimum evaporating temperature of the expansion valve (at minimum “0” bar atmospheric) and the high pressure is the refrigerant pressure under 30 ºC); the frequency shall be 10 times/min to 40 times/min during the process of repeated movement 200 000 times. Conduct test for static superheat. The change in super heat before and after vibration test should be less than ± 1K.

6.14 Capillary Bending Test

Bending test should be carried out by bending the capillary at minimum angle of 90° to original joint position at diaphragm top and joint at bulb with minimum tension of 20 N to meet the requirement of **5.13** and **5.14**.

7 TEST SCHEDULE

7.1 Routine Test

It is required to conduct routine test to every expansion valve and the schedule of test shall abide by the stipulation of Table 6.

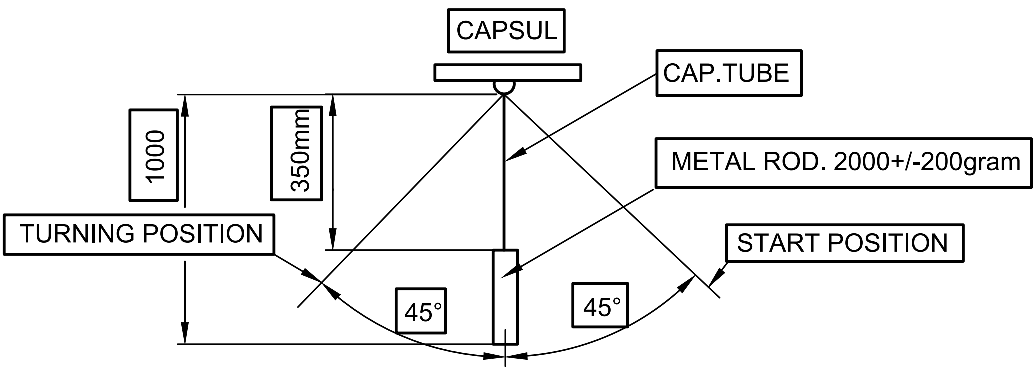


FIG. 8 CAPILLARY BENDING TEST

Table 6 Schedule of test

(*Clause* 7.1)

Sl No.	Test	Production Routine Test (100 Percent)	Sampling Inspection	Type Test (Audit)	Requirements	Test Method
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Adjusting range of static super heat				5.2	6.3
ii)	Air tightness				5.4	6.5
iii)	Leakage in external equalization pipe	yes			5.6	6.7
iv)	Static super heat		yes		5.7	6.8
v)	Internal leakage of throttle opening				5.8	6.9
vi)	Nominal cooling capacity				5.9	6.10
vii)	Hysteresis			yes	5.11	6.11
viii)	Hydraulic strength				5.3	6.4
ix)	Environmental heat resistance	Not Applicable			5.5	6.6
x)	Extension cooling capacity		Not Applicable		5.10	6.10
xi)	Vibration resistance				5.12	6.12
xii)	Working life				5.13	6.13

NOTE — Items marked 'yes' need inspection as shown above. Items marked as 'Not applicable' inspection test need not be carried as indicated. Type test is must for all.

7.2 Acceptance Test

7.2.1 The expansion valves produced in batch shall be subject to acceptance test. The lot size, sampling plan, inspection level and acceptable quality level shall be determined by the quality inspection department of the manufacturer.

7.2.2 Expansion valves shall be sampled from the qualified products in routine test and inspection items and test methods shall comply with the stipulation in Table 6.

The sampling for acceptance test shall be as per IS 2500 (Part 1).

7.3 Type Test

7.3.1 When there are significant improvements in the approved products or while developing new products, type test shall be conducted. Inspection items shall comply with the specification of Table 6.

7.3.2 In the case of faults during the type test, it is required to retest after the faults are removed.

8 MARKING, PACKAGING, TRANSPORTATION AND STORAGE

8.1 Marking

8.1.1 Every product or packing case shall be marked with:

a) Product name, code number, capacity, refrigerant, working temperatures approvals;
b) Manufacturer's name; and
c) Country of manufacturing.

8.2 Packaging

All the parts shall be packed in such a way that no damage is caused to them during transit.

8.3 Transportation

During the transportation of products, it is required to avoid collision, throw, dropping, direct exposure to the rain and chemical pollution.

8.4 Storage

Products shall be stored in a dry and ventilated warehouse without corrosive gas.

9 BIS CERTIFICATION MARKING

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
292 : 1983	Leaded brass ingots and castings (*second revision*)
410 : 1977	Cold rolled brass sheet, strip and foil (*third revision*)
6911 : 2017	Stainless steel plate, sheet and strip — Specification (*second revision*)
2500(Part 1) : 2000/ISO 2859-1 : 1999	Sampling inspection procedures: Part 1 Attribute sampling plans indexed by acceptable quality limit (AQL) for lot-by-lot inspection (*third revision*)
9844 : 1981	Methods of testing corrosion resistance of electroplated and anodized aluminum coatings by neutral salt spray test

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

Refrigeration and Air Conditioning Sectional Committee, MED 03

Organization	*Representative(s)*
Indian Institute of Technology, Roorkee	Prof (Dr) Ravi Kumar (***Chairman***)
Annapurna Electronics and Services Ltd, Hyderabad	Shri G. K. Prasad Shri J. S. Sastry (*Alternate*)
Bureau of Energy Efficiency, New Delhi	Shri Sameer Pandita Shri Kamran Shaikh (*Alternate*)
Blue Star Ltd, Mumbai	Shri Jitendra Bhambure Shri Sunil Jain (*Alternate*)
BSH Household Appliances Manufacturing Pvt Ltd, Chennai	Shri Vijaya Kumar Loganathan Shri Anand Balasubramanian (*Alternate*)
Carrier Aircon Ltd, Gurugram	Shri Bimal Tandon Shri D. Bhattacharya (*Alternate*)
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Centre for Science and Environment, New Delhi	Shri Chandra Bhushan
Consumer Education and Research Centre, Ahmedabad	Ms Sweta Mahajan
Danfoss Industries Pvt Ltd, Gurugram	Shri Madhur Sehgal Shri K. L. Nagahari (*Alternate* I) Shri Kiran Kumar M. N. S. V. (*Alternate* II)
Electrical Research and Development Association, Vadodara	Shri Gautam Brahmbhatt Shri Rakesh Patel (*Alternate*)
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Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE), New Delhi	Dr Jyotirmay Mathur Shri Ashish Rakheja (*Alternate*)
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International Copper Association India, Mumbai	Shri Sanjeev Ranjan Shri Shankar Sapaliga (*Alternate*)
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LG Electronics India Pvt Ltd, New Delhi	Shri Aditya Anil Shri Rajat Shrivastava (*Alternate*)
National Thermal Power Corporation, Noida	Shri D. K. Suryanarayan Shri S. K. Jha (*Alternate*)

Organization	*Representative(s)*
Refrigeration & Airconditioning Manufacturers Association, New Delhi	Shri Gurmeet Singh Shri R. K. Mehta (*Alternate*)
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In personal capacity, New Delhi	Shri S. T. H. Faridi
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Ms Khushbu Jyotsna Kindo
Scientist 'C' (MED), BIS

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